TAGGING STUDY OF WINTER FLOUNDER TAKEN IN BARNEGAT BAY

Progress Report for the Period
December 1978 through July 1979

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Tagging Study of Winter Flounder Taken in Barnegat Bay

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Introduction

The population of winter flounder, found from Labrador to Georgia (Leim and Scott 1966), has been reported by many investigators to consist of geographically localized stocks associated with individual estuaries or distinct coastal areas (Lobell 1939, Perlmutter 1947, Saila 1961, McCracken 1963, Poole 1966, Howe and Coates 1975). A great deal of this information as well as the yearly movements of winter flounder were obtained through tagging studies. Adults return to their natal estuaries in late fall, spawn in winter, and move offshore into the ocean where they remain from late spring through early fall.

Previous studies at OCGS (Tatham et al. 1977a, b and 1978a, b; Danila et al. 1979) examined specimens from only a portion of Barnegat Bay and none from contiguous bays. The winter flounder found in the Bay are subject to impingement and entrainment losses at OCGS. Consequently, in order to properly address the significance of the losses, the geographic range of the Barnegat Bay stock should be determined.

Thus, the present study was primarily designed to determine the spatial distribution and movements of winter flounder found in Barnegat Bay. Adult winter flounder were tagged during the winter of 1978-79 and their movements during the following 18 months, as inferred by tag recaptures, will be analyzed.

The secondary objectives of the study were to demonstrate the survival of winter flounder released in the discharge canal of OCGS after impingement on the traveling screens and to determine if individuals reentered the intake canal and were reimpinged.

Materials and Methods

Adult winter flounder were collected on the OCGS traveling screens (Sta. 9; Fig. 1) during regularly scheduled impingement sampling from 11 December 1978 through 1 February 1979. Impingement sampling procedures were described by Miller and Danila (1979). Adults were removed as quickly as possible from the impingement sample and placed in two nearby holding tanks that held approximately 1,000 liters each of ambient temperature water pumped continuously from the intake canal. Excess water drained through a standpipe and a flow-through condition was maintained. However, on several occasions the flow was halted as the pumps were shut off for various periods by plant personnel or the water lines froze due to extremely cold temperatures.

Specimens were usually tagged on the day following capture, although on one occasion they remained in the holding tanks about 3.5 days. The number of winter flounder held in each tank ranged from 30 to 80.

Winter flounder were carefully removed from the tanks, placed on a wet measuring board, and their length recorded to the nearest mm. The sex of the specimens was usually determined by visual examination as milt flowed freely from most males and the outline of the enlarged, prominant ovaries of ripe females were visible externally. A second criteria used

for sex determination was that the ventral caudal peduncle of a male was rough to the touch because of prominant scale ctenii, whereas that of a female was smooth (Howe and Coates 1975). When a positive determination was not possible, the sex was recorded as unknown. Injuries, anomalies, diseases, and abnormalities were recorded and only apparently healthy individuals were tagged. A 1.3-cm diameter white Petersen disc tag (Floy Tag Mfg., Inc., Seattle, WA) printed with information for its return and with an identifying number from 000 through 999 was used (Fig. 2). The specimen to be tagged was placed on a wet foam mat. A nickel pin was first inserted through the hole in the center of a non-printed yellow disc. The pin was then pushed through the ventral musculature in the nape region of the fish. A printed white disc was then placed on the pin after it pierced the pigmented dorsal side. Excess pin material was cut off and the remaining stub was crimped. This secured the tag to the fish (Fig. 3). All information (i.e., length, sex, condition, tag number) was recorded in a data log. The specimen was then placed either in a cooler or taken directly to the impingement sampling station. Tagged fish were gently released into the screen wash flume and washed into the discharge canal (Fig. 1). However, some individuals were held for various periods for tagging mortality and tag-shedding observations either in one of the 1,000-liter holding tanks previously mentioned or in a 900-liter holding tank with a similar flow-through water system adjacent to Sta. 13 (Fig. 1).

The tagging study was publicized to encourage the return of tags by contacting local and regional newspapers and fishing periodicals, writing letters to commercial fishermen licensed for Barnegat Bay, and placing

posters (Fig. 4) in areas of Ocean County frequented by fishermen. A reward of $1.00 was sent to all persons who returned a tag. In some cases, only incomplete information on the location and date of capture were available despite followup letters sent to the tag returner requesting the additional information.

Results

Tagging

Some 971 winter flounder were tagged and released from 12 December 1978 through 2 February 1979. Most (n=776, 80%) were females, 193 (20%) were males, and 2 were of unknown sex. An additional 21 tags used during the tag-shedding and tagging mortality study were not reused. Thirteen tags were not received or were lost during the course of the study, but five tags were found to be duplicated and the fish were included in the above total of released fish. This accounts for the total of 1,000 tags ordered for the study.

The length-frequency distribution of winter flounder tagged (Fig. 5) showed that in general females were larger than males. This has been found for most northeastern stocks of winter flounder (Berry et al. 1965, Poole 1966, Lux 1973) and also for Barnegat Bay (Danila 1977, 1978b). Males ranged in length from 218 to 361 mm and had a mean length of 264 mm. Most (87%) were between 231 and 290 mm. Females ranged from 219 to 400 mm and averaged 293 mm. Some 56% were between 281 and 320 mm. The mean length of all winter flounder tagged was 288 mm.

Some 29.3% of the winter flounder had no obvious external injuries or physical abnormalities when tagged. Almost half (45.6%) had some hemorrhagging on either the fins or body caused by impingement or by the

sampling gear. Other injuries included abrasions on the body or missing scales (19.5%) and split fins or damaged fin rays (9.2%). These injuries were relatively minor and did not seem to affect the condition of any of the tagged specimens. Nodules on fins and the body produced by the viral disease lymphocystis (Murchelano and Bridges 1976; Danila 1977, 1978b) were found on 5.4% of the specimens. Two pigmentation anomalies, staining and ambicoloration (Norman 1934; Danila 1977, 1978b), were also noted (6.3 and 0.1%, respectively). The above percentages total more than 100% because many specimens had more than one abnormality present.

Tag-shedding and tagging mortality

A total of 32 winter flounder (24 females, 8 males) was held at various times to determine if tagging caused immediate or delayed mortalities or if tags were shed or lost after a period of time. Unfortunately, shutoff of circulating water to the holding tanks caused mortalities that limited the results obtained. Eight winter flounder were tagged and held on 12 and 15 December. However, five died on 12 January when the water in the tank decreased to -0.8 C because of the extremely cold ambient temperatures. Ice had formed on the surface of the water and on the walls of the tank. Eight additional winter flounder were tagged and placed into the tank after the ice was removed.

On 19 January the holding tanks had about 1 cm of ice on the surface after the circulating pump had inadvertently been shut off. A hole was cut in the ice. Measurements taken 25 cm below the surface revealed that the temperature was 0 C and dissolved oxygen 12.6 ppm. The pump was restarted

on 22 January and on 24 January the tanks were rechecked. Four specimens were dead, probably from prolonged exposure to the cold water in the tanks.

On 26 January the pump was found shut down again. The winter flounder exhibited stress such as swimming towards the surface. This was probably due to low dissolved oxygen in the tanks. Four of the seven remaining winter flounder held for study as well as 16 newly tagged fish were transferred to another holding tank near the dilution pump discharge. One previously held specimen was released. Two specimens were unaccounted for. They had perhaps jumped from the tank and were then possibly released by plant personnel as one of these fish was later recaptured.

On 27 February, all 20 winter flounder held in the discharge area died after the pump was shut off and a thick layer of ice formed. All mortalities were assumed to be from low temperature and low dissolved oxygen rather than from tagging.

In summary, two winter flounder were held for about 2.5 months and most of the rest for about a month before they died. All deaths were attributed to effects of holding rather than tagging. Observations indicated that minor injuries present such as abrasions or hemorrhagging at the time of tagging had healed or noticeably improved. No loss of tags occurred and no infections or irritation from the tags were noted.

Returns

Seventy-six winter flounder were recaptured from late December 1978 through 10 July 1979 (Table 1, Fig. 6) for a tag return rate of 7.8%. Eight (including one specimen taken twice) were collected on the OCGS

screens during impingement sampling. Seven of these were in good condition and immediately released again. The other 68 returns were from sport fishermen (n=42), a Barnegat Bay fyke netter (22), and commercial trawler fishermen in the ocean (4). As expected, most (n=64) were females, 10 were males, and 2 were unknown (the tagging data of one was lost and one was released after reimpingement without obtaining the tag number or sex of the specimen). A chi-square test indicated that a similar proportion of males and females was found for both tagged and returned specimens and no selectively by sex occurred at recapture. Although slightly skewed towards larger sizes, the proportion of recaptured winter flounder within each size-class by sex (Fig. 7) did not significantly differ from the length-frequencies at time of tagging.

The mean length at time of tagging of all recaptured females was 301 mm and that of males was 272 mm. Females taken by commercial trawler fishermen (n=3) were slightly larger (mean of 309 mm) than those taken by sport fishermen (35, 305 mm) or by the fyke netter (19, 294 mm). The six males caught by sport fishermen (mean of 276 mm) were larger than the three taken by fyke net (264 mm) or the one by trawl (267 mm). The six females taken on the OCGS screens and measured had a mean length of 291 mm.

Winter flounder were taken on the OCGS screens in January and February when impingement for this species is usually greatest (Miller 1978, 1979; Miller and Danila 1979). One specimen (No. 633) was reimpinged about 36 h after tagging. Although it may have traveled the 10 km through Oyster Creek, the Bay, and Forked River to reach the OCGS screens again, it could have been improperly released and remained in the screenwash sluiceway

during this time without traveling down the screenwash flume into the discharge canal. This may also be true of No. 797, although the 3-day period before its recapture makes this less likely. Fish No. 637 was reimpinged twice during February. The OCGS recaptures represented 0.7% of all fish tagged, but impingement sampling only took place for approximately 26 to 29 h a week in January and February and not every specimen was examined during sampling.

Most returns from December through February were from a fyke netter who fished along the western shoreline of Barnegat Bay from Forked River to Waretown. His catch included 2.3% of the winter flounder tagged. Unfortunately, exact dates and places of capture are not known. Two fish were also caught by a sport fisherman at the Route 9 bridge in Oyster Creek in late January and early February.

Most returns in 1978-79 were from sport fishing during late March through early May. The two approaches to Barnegat Inlet, Oyster Creek and Double Creek Channels, were relatively heavily fished during this period for winter flounder which left the Bay as the water warmed in spring. Other returns were scattered in Barnegat Bay, Little Egg Harbor, and a few were from other nearby areas.

After early May, all returns were from the ocean. Most of the early returns were taken relatively nearby and the later returns were from the continental shelf about 27 to 44 km off central New Jersey.

Daily movement of tagged fish was calculated by measuring the shortest water route from OCGS to their point of capture divided by the number of days they were at liberty. The winter flounder taken by sport fishing

(n=42) averaged 0.17 ± 0.04 km/day and those by commercial trawlers (4), 0.52 ± 0.15 km/day. After tagging, released fish generally moved southeasterly towards Barnegat Inlet and then northeasterly to offshore waters for the summer.

Discussion

Specimens selected for tagging in this study were usually 240 mm or larger as it was felt that these fish would most likely be taken by sport and commercial fishermen. This accounts for the preponderance of females tagged as they are generally larger than males. Initial holding of specimens taken after impingement allowed tagging crews to cull out those specimens in poor condition. Most of the fish selected for tagging had only minor injuries from impingement or capture and their condition was probably not significantly affected. Based on the few specimens used in the tagging mortality study, the handling and application of tags did not appreciably harm the winter flounder. All mortalities were attributed to extreme cold or lack of oxygen during holding. Umminger and Mahoney (1972) reported that the normal freezing point of winter flounder serum was about -0.7 to -0.8 C and water in the holding tanks at times approached these temperatures.

Tag returns showed that some winter flounder left Oyster Creek, reentered Forked River, and were reimpinged on the OCGS traveling screens. Although only a few winter flounder were recaptured, additional fish may have been reimpinged as the total sampling effort was relatively small. Most winter flounder were in good condition after impingement; mortality at OCGS is very low, especially for larger specimens (Miller 1978, 1979).

Barnegat Inlet was the major waterway through which winter flounder left Barnegat Bay. Sport fishing catches of winter flounder are usually

greatest in this area as winter flounder concentrate there before leaving the Bay (Danila 1978a). Evidently not all winter flounder used Barnegat Inlet to enter the ocean since some returns were from Little Egg Harbor. These fish would presumably have used Beach Haven and Little Egg Inlets during their seaward migration. The one fish caught in Manasquan Inlet may have left Barnegat Bay via the Point Pleasant Canal. One early migrator was taken at Shark River Inlet on 30 March and could have used either the Canal or Barnegat Inlet. Tag returns indicated that winter flounder apparently spend the summer offshore and to the north, rather than directly off Barnegat Inlet. This observation, however, may be biased due to possibly greater commercial fishing effort to the north. The rates of movement calculated were artificial in that they were mean values but, nonetheless, give an idea of the movements of winter flounder over time.

Definition of the geographical range and relative discreteness of the Barnegat Bay winter flounder stock will not be ascertained until a sufficient number of recaptures are made during the winter of 1979-80. Definition of its estuarine breeding range will allow a better evaluation of OCGS and other impacts. Future returns could also be used to calculate natural and fishing mortalities and, if sufficient data is collected, additional estimations of growth rate.

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Table 1. Summary of all winter flounder tag returns from late December 1978 through 10 July 1979 by method of recapture.

	Tag No.	Length	Sex	Date Released	Date Recaptured	Days at Large	Place Recaptured[b]	Distance Traveled from OCGS (km)	Major Compass Direction of Movement	Rate of Travel (km/day)
Impingement Sampling[a]	?	?	?	15 - 29 December	3 January	5 - 19	OCGS	10.0	Circular	0.53 - 2.00
	191	291	F	19 December	19 January	31	OCGS	10.0	Circular	0.32
	633	320	F	24 January	25 January	1.5	OCGS	10.0	? Circular	6.67
	448	355	F	4 January	26 January	22	OCGS	10.0	Circular	0.45
	797	232	F	29 January	1 February	3	OCGS	10.0	Circular	3.33
	637	281	F	? 24 January	1 February	< 8	OCGS	10.0	Circular	> 1.25
	637	281	F	1 February	27 February	26	OCGS	10.0	Circular	0.38
	391	245	F	28 December	2 February	36	OCGS	10.0	Circular	0.28
Sport fishing	664	299	F	24 January	28 January	4	OC - Rt 9 bridge	0.8	E	0.20
	108	281	M	19 December	5 February	48	OC - Rt 9 bridge	0.8	E	0.02
	868	305	F	29 January	18 March	48	BB - off OC mouth	3.7	E	0.08
	133	275	F	22 December	20 March	88	BB - Mud Channel	7.6	E	0.09
	856	350	F	30 January	22 March	51	OC Ch	6.6	SE	0.13
	890	255	F	29 January	22 March	52	Barnegat Light	10.1	SE	0.19
	656	289	F	24 January	23 March	58	LEH - Peahala Park	27.4	S	0.47
	273	309	F	22 December	29 March	97	LEH - Beach Haven	35.3	SW	0.36
	992	310	F	2 February	29 March	55	BB - Harvey Cedars	16.5	SW	0.30
	422	289	M	4 January	30 March	85	Shark River Inlet	60.4	NE	0.71
	333	290	F	28 December	31 March	93	OC Ch	7.2	SE	0.08
	928	323	F	30 January	31 March	60	Barnegat Light	11.1	SE	0.19
	944	319	F	30 January	31 March	60	BB - off Barnegat	13.6	SW	0.23
	478	259	M	4 January	7 April	93	Toms River	20.0	NE	0.22
	896	311	F	30 January	? 8 April	? 68	LEH - Beach Haven	33.5	SW	0.49
	277	278	F	22 December	? 15 April	? 114	Barnegat Light	11.1	SE	0.10
	839	300	F	30 January	15 April	75	DC Ch	8.2	SE	0.11
	034[c]	?	?	15 December	18 April	124	BB - Gulf Point	11.7	SW	0.09
	049	298	F	19 December	20 April	123	OC Ch	7.9	SE	0.06
	488	312	F	4 January	20 April	106	OC Ch	7.9	SE	0.07
	465	326	F	4 January	21 April	107	OC Ch	7.9	SE	0.07
	472	292	F	4 January	21 April	107	DC Ch	8.2	SE	0.08
	905	390	F	30 January	21 April	81	DC Ch	9.5	SE	0.12
	924	312	F	2 February	21 April	78	DC Ch	8.2	SE	0.11
	947	270	M	2 February	21 April	78	Barnegat Inlet	11.7	SE	0.15
	339	273	F	29 December	22 April	114	OC Ch	5.5	SE	0.05
	065	300	F	19 December	23 April	125	DC Ch	8.8	SE	0.07
	974	343	F	30 January	23 April	83	OC Ch	7.9	SE	0.10
	824	304	F	30 January	23 April	83	Barnegat Light	12.4	SE	0.15
	114	300	F	19 December	24 April	126	OC Ch	7.2	SE	0.06
	030	333	F	15 December	25 April	131	LEH - Westecunk Creek	28.7	SW	0.22
	460	272	F	4 January	26 April	112	BB - off OC mouth	4.7	E	0.04
	739	309	F	29 January	26 April	87	OC Ch	7.9	SE	0.09
	475	293	F	4 January	28 April	114	LEH	32.8	SW	0.29
	444	310	F	4 January	29 April	115	DC Ch	8.4	SE	0.07
	732	284	M	29 January	29 April	90	BB - off FR mouth	5.3	NE	0.06
	723	284	F	29 January	4 May	95	OC Ch	7.2	SE	0.08
	322	310	F	28 December	6 May	129	BB - Harvey Cedars	16.5	SW	0.13
	359	312	F	28 December	7 May	130	BB - Harvey Cedars	16.5	SW	0.13
	043	328	F	15 December	10 May	148	Manasquan Inlet	49.8	NE	0.34
	829	257	F	30 January	10 May	100	Ocean - off Seaside	33.6	N	0.34
	245	321	F	22 December	15 May	144	Ocean - off Harvey Cedars	15.1	S	0.10

Table 1. (Cont.)

	Tag No.	Length	Sex	Date Released	Date Recaptured	Days at Large	Place Recaptured	Distance Traveled from OCGS (km)	Major Compass Direction of Movement	Rate of Travel (km/day)
Fyke Net[d]	28	300	F	15 December	December - February	?	FR through WT	< 5.5	NE - SW	?
	57	325	F	15 December	December - February	?	FR through WT	< 5.5	NE - SW	?
	155	241	M	20 December	December - February	?	FR through WT	< 5.5	NE - SW	?
	179	263	F	20 December	December - February	?	FR through WT	< 5.5	NE - SW	?
	287	320	F	22 December	December - February	?	FR through WT	< 5.5	NE - SW	?
	358	270	F	28 December	December - February	?	FR through WT	< 5.5	NE - SW	?
	587	284	F	4 January	December - February	?	FR through WT	< 5.5	NE - SW	?
	588	308	F	4 January	December - February	?	FR through WT	< 5.5	NE - SW	?
	628	285	F	24 January	December - February	?	FR through WT	< 5.5	NE - SW	?
	632	321	F	24 January	December - February	?	FR through WT	< 5.5	NE - SW	?
	703	313	F	29 January	December - February	?	FR through WT	< 5.5	NE - SW	?
	712	299	F	29 January	December - February	?	FR through WT	< 5.5	NE - SW	?
	714	285	M	29 January	December - February	?	FR through WT	< 5.5	NE - SW	?
	738	250	F	29 January	December - February	?	FR through WT	< 5.5	NE - SW	?
	746	299	F	29 January	December - February	?	FR through WT	< 5.5	NE - SW	?
	758	257	F	29 January	December - February	?	FR through WT	< 5.5	NE - SW	?
	777	259	F	29 January	December - February	?	FR through WT	< 5.5	NE - SW	?
	815	318	F	29 January	December - February	?	FR through WT	< 5.5	NE - SW	?
	860	313	F	30 January	December - February	?	FR through WT	< 5.5	NE - SW	?
	883	310	F	30 January	December - February	?	FR through WT	< 5.5	NE - SW	?
	900	293	F	30 January	December - February	?	FR through WT	< 5.5	NE - SW	?
	968	267	M	30 January	December - February	?	FR through WT	< 5.5	NE - SW	?
Commercial Trawler	916	302	F	30 January	2 May	92	Ocean off Manasquan	59.2	NE	0.64
	971	267	M	30 January	31 May	122	Ocean off Manasquan	71.1	NE	0.58
	635	290	F	24 January	21 June	149	Ocean off Asbury Park	67.5	NE	0.45
	945	336	F	30 January	10 July	162	Ocean off Manasquan	65.7	NE	0.41

[a] Number of first impinged specimen not ascertained. All fish except No. 191 released again in good condition. No. 637 originally accidentally released or escaped from tagging mortality study. Actual date of first release unknown.

[b] Place name abbreviations:

BB - Barnegat Bay
DC Ch - Double Creek Channel
FR - Forked River
LEH - Little Egg Harbor
OC - Oyster Creek
OC Ch - Oyster Creek Channel
OCGS - Impingement Sampling Station
WT - Waretown

[c] Original data lost for this specimen.

[d] Exact dates and locations of fyke net returns are not known. Various nets were set along shore from Forked River to Waretown from December through February.

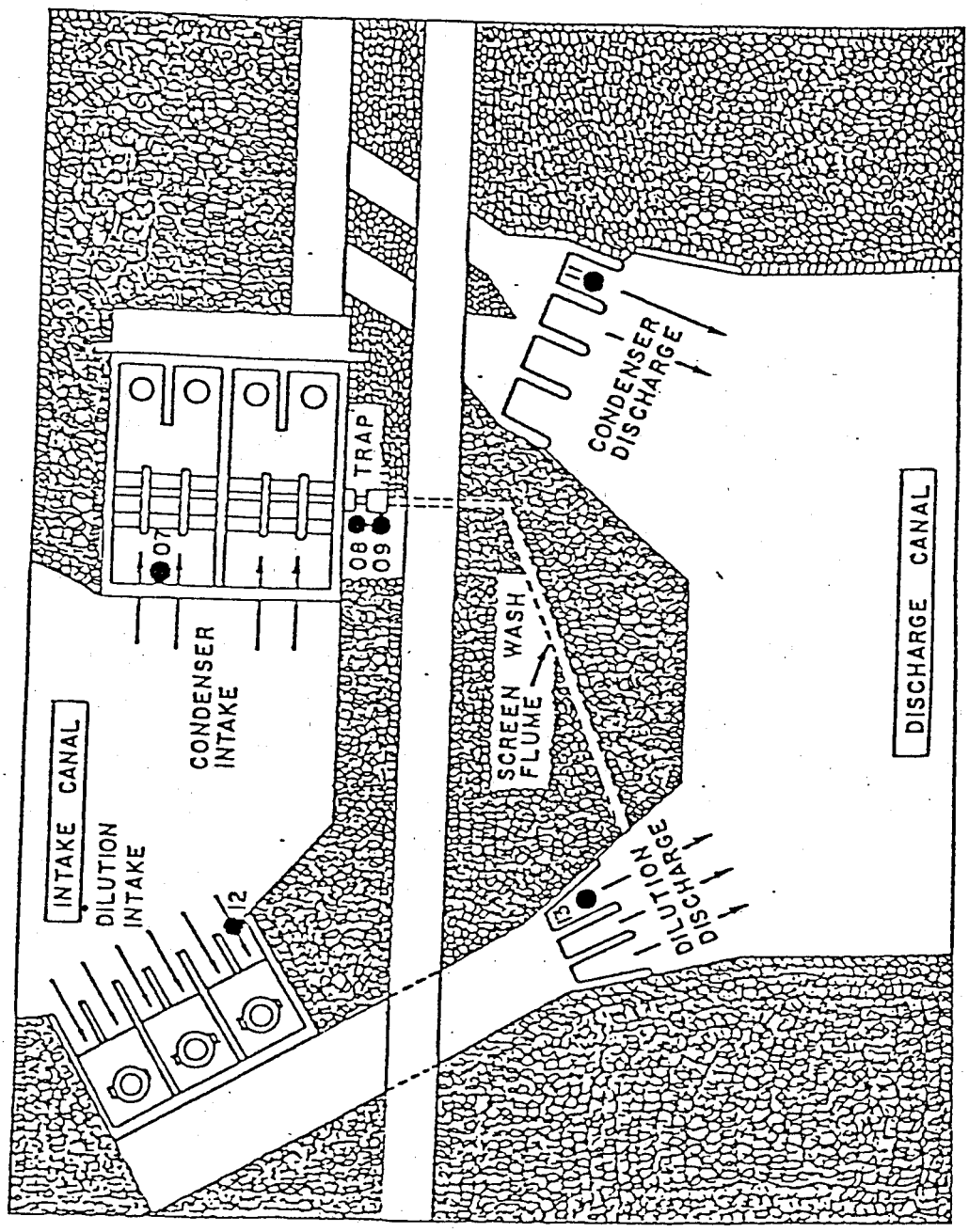
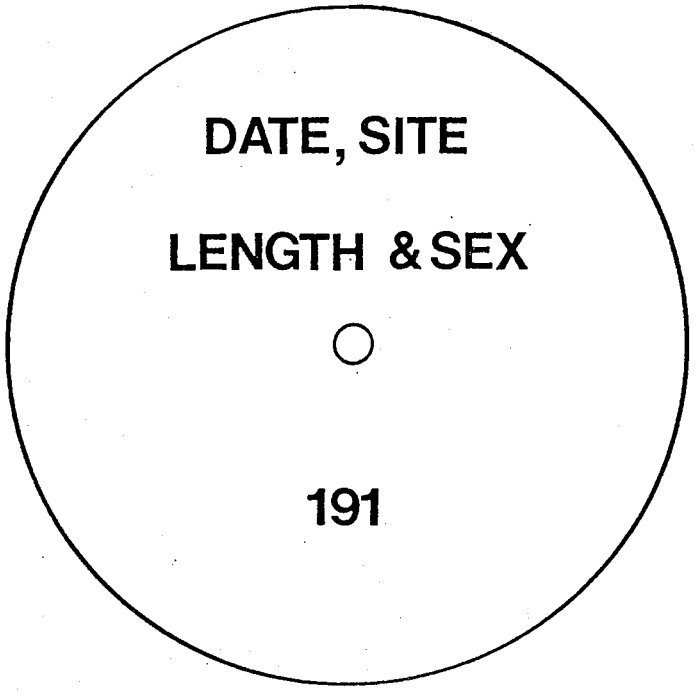
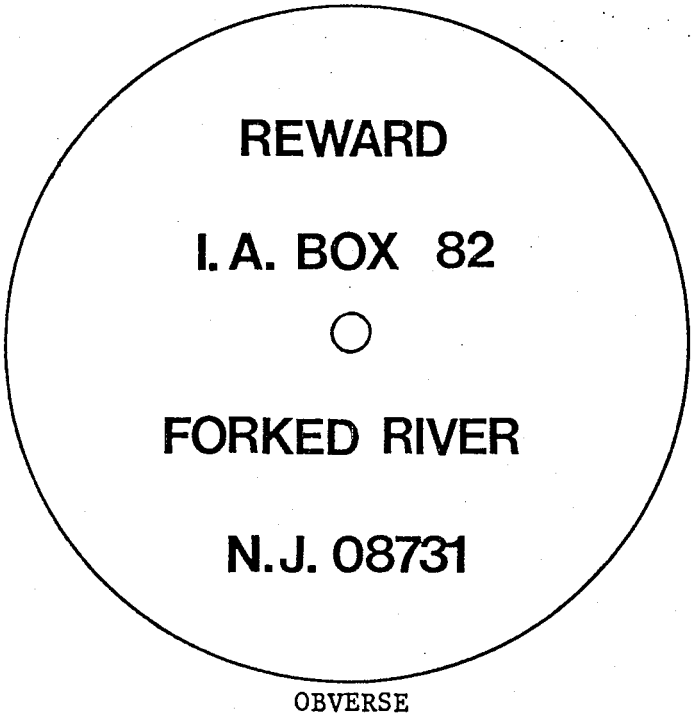


Fig. 1. Diagram of the intake and discharge of the circulating water system and the dilution pumps at the Oyster Creek Generating Station.



REVERSE



OBVERSE

Fig. 2. Reverse and obverse sides of Petersen disc tag used on winter flounder taken at OCGS from 12 December 1978 through 2 February 1979.

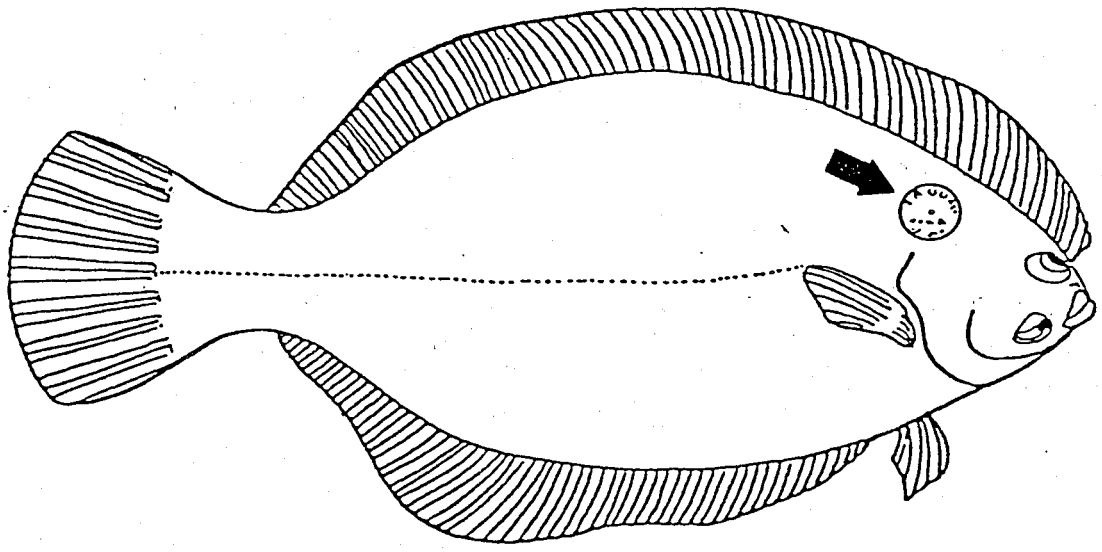


Fig. 3. Position of Petersen disc tag used on winter flounder taken at OCGS from 12 December 1978 through 2 February 1979.

Fig. 4. Reward poster used to publicize the winter flounder tagging study.

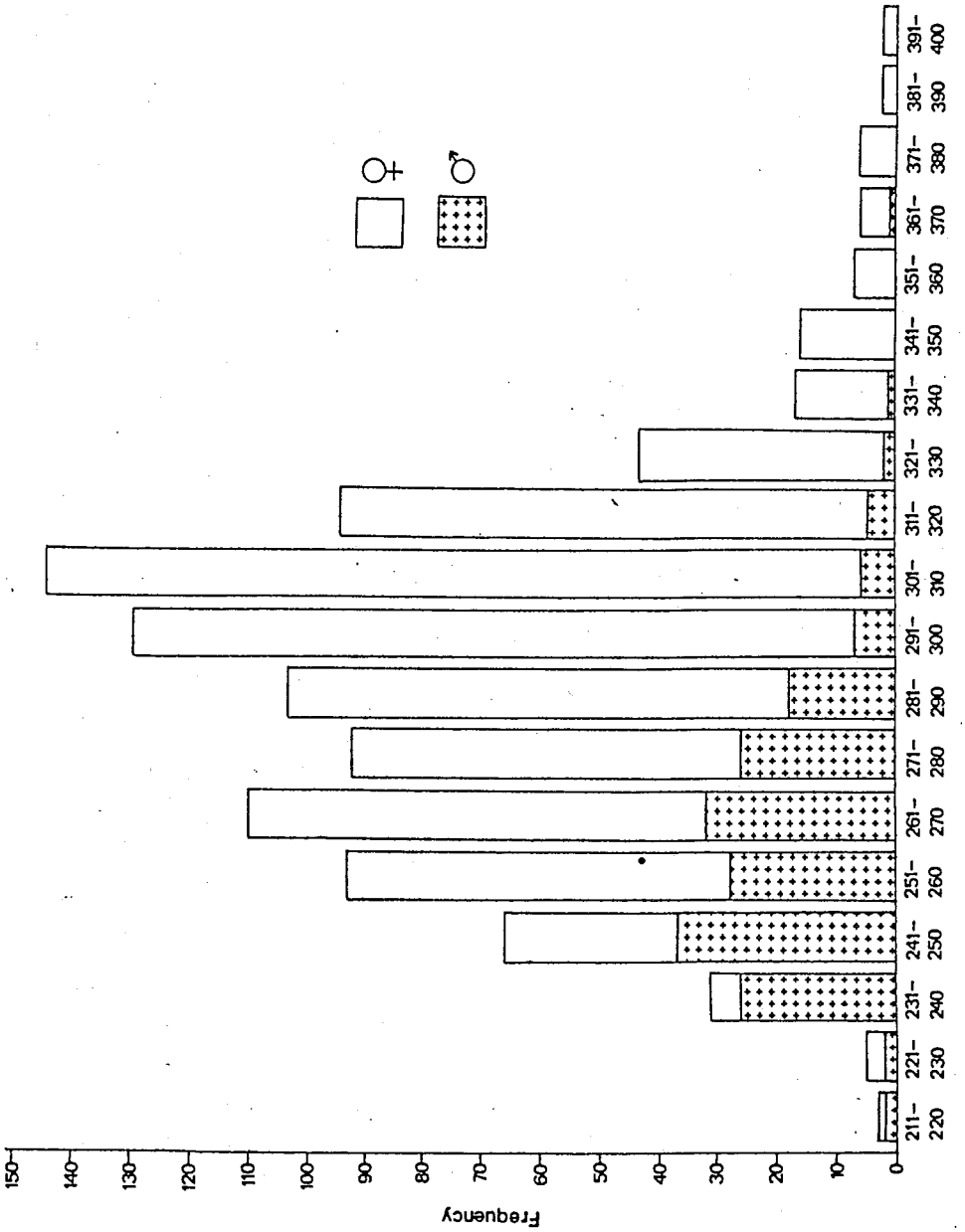
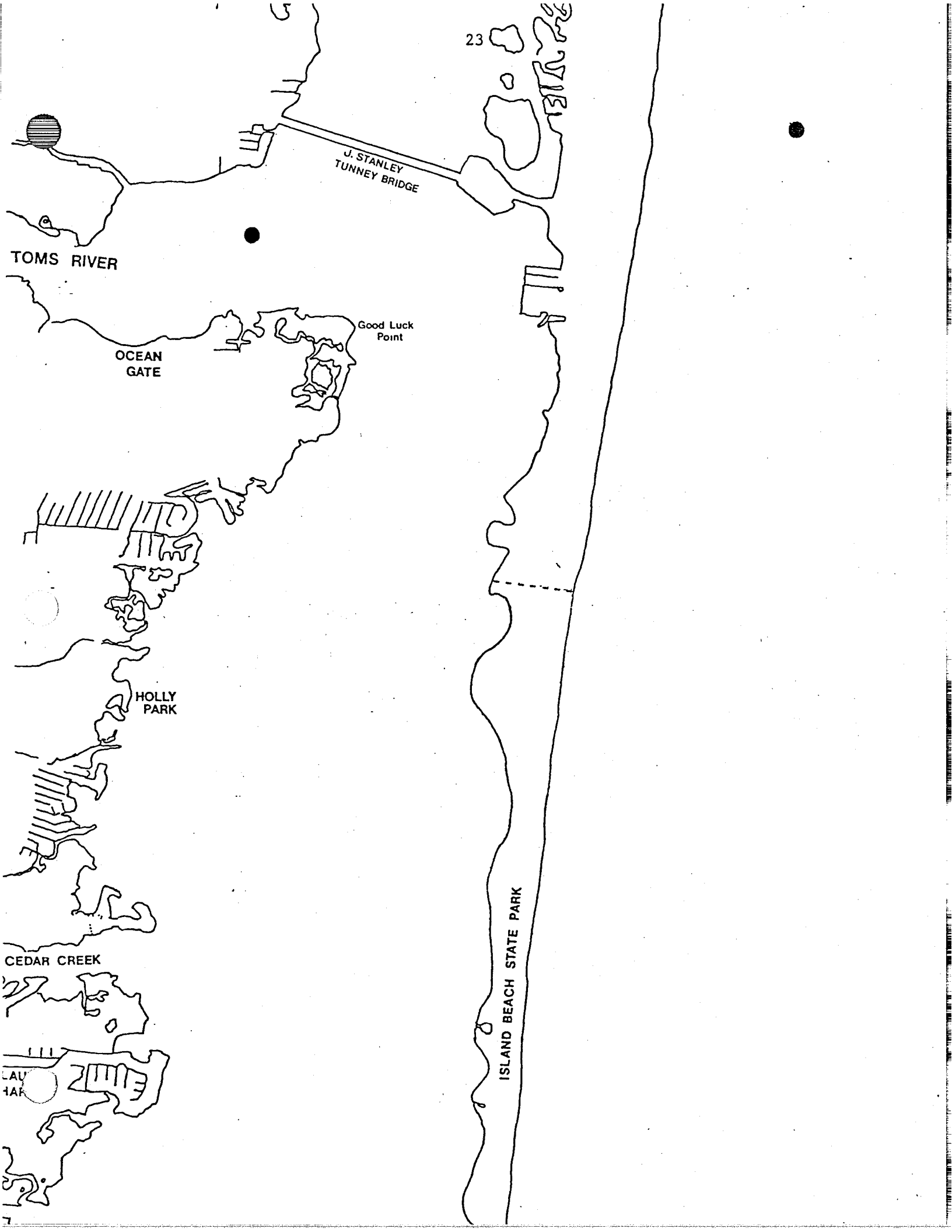
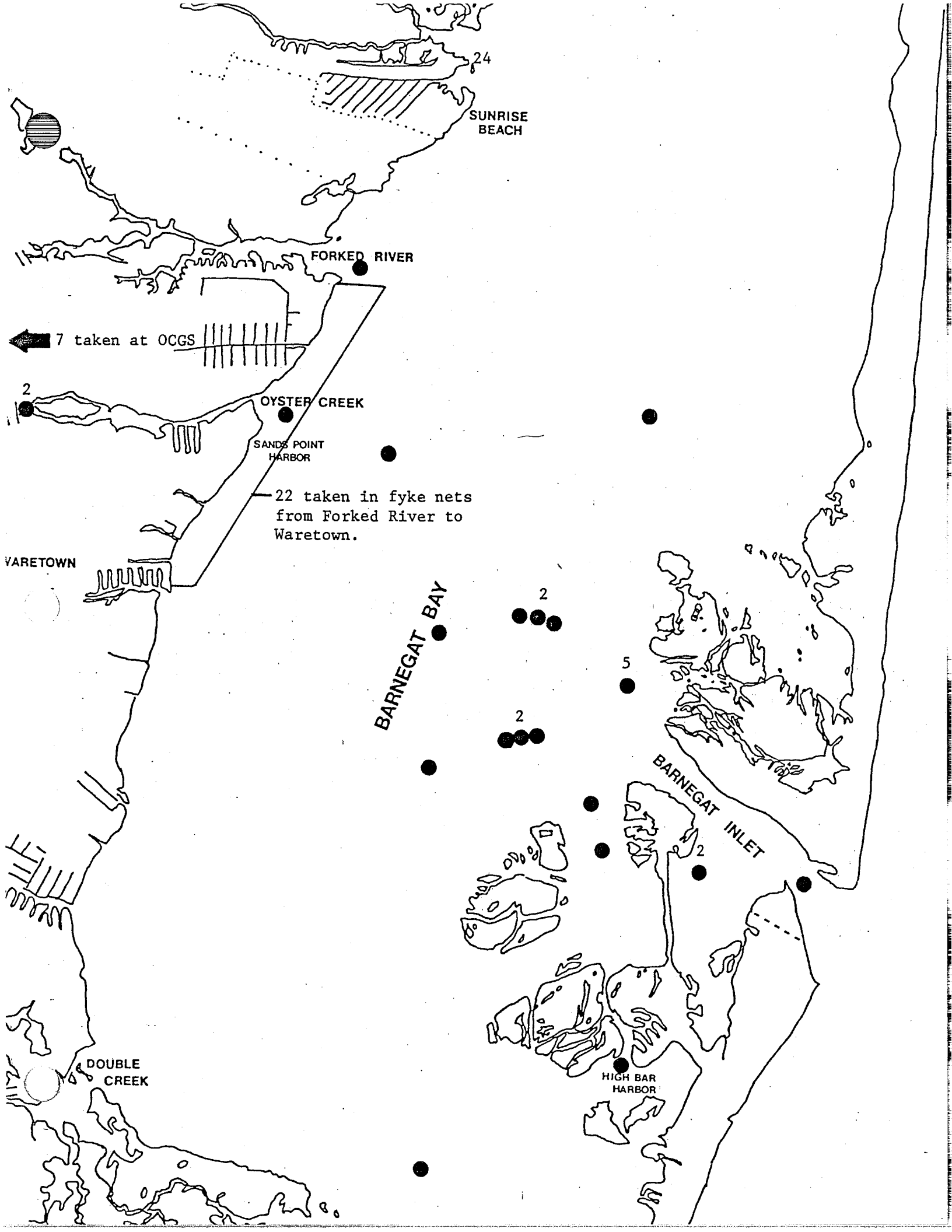
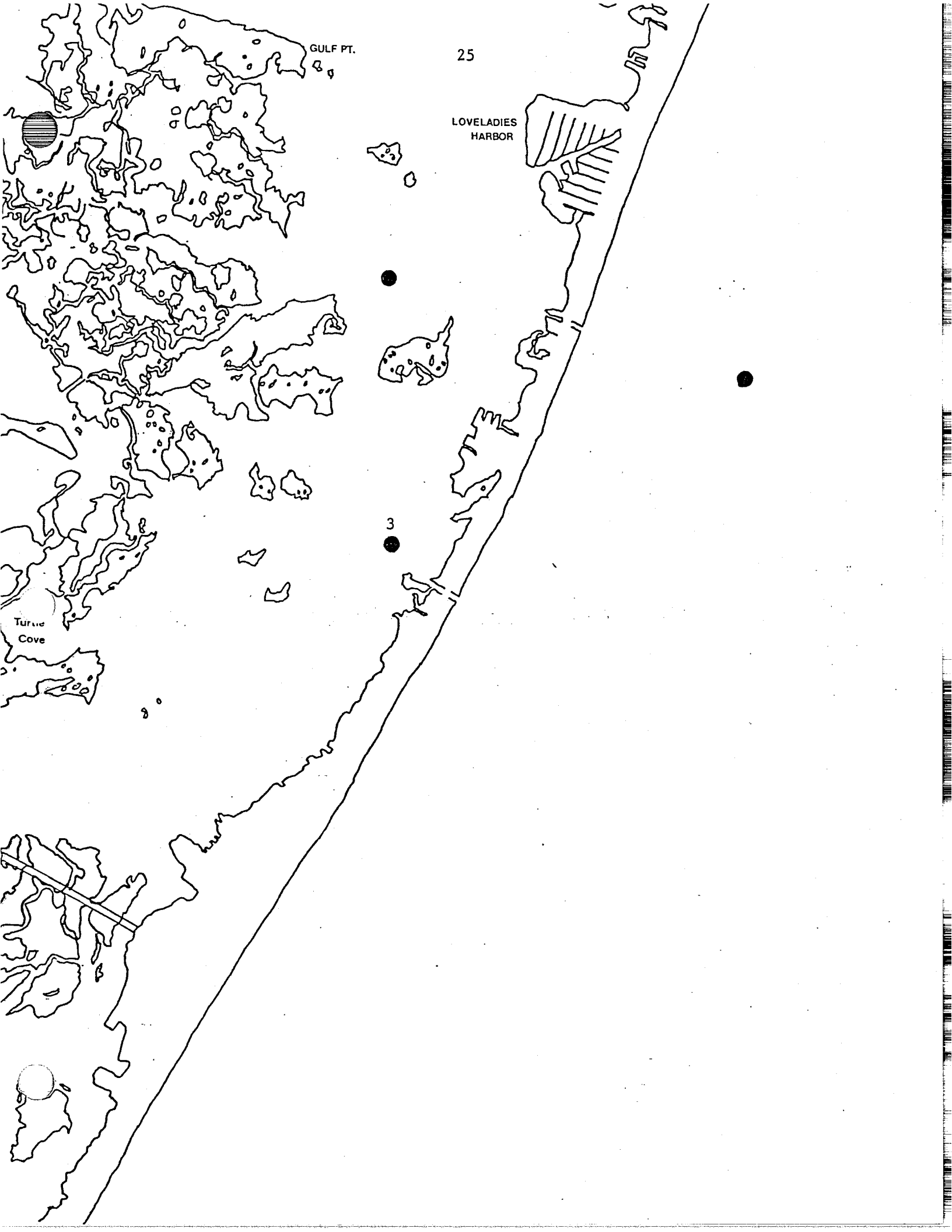


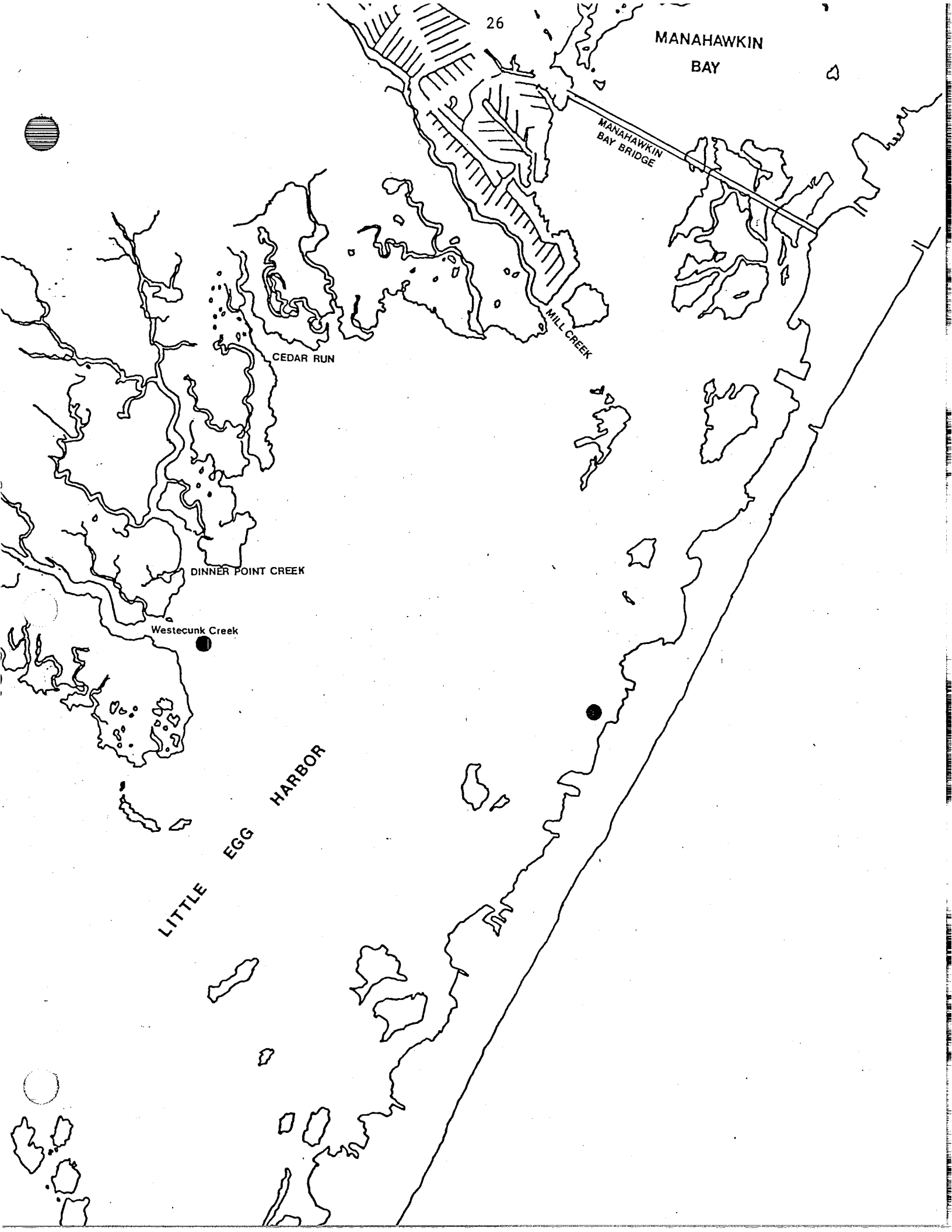
Fig. 5. Length-frequency distribution of male and female winter flounder tagged at OCGS from 12 December 1978 through 2 February 1979.

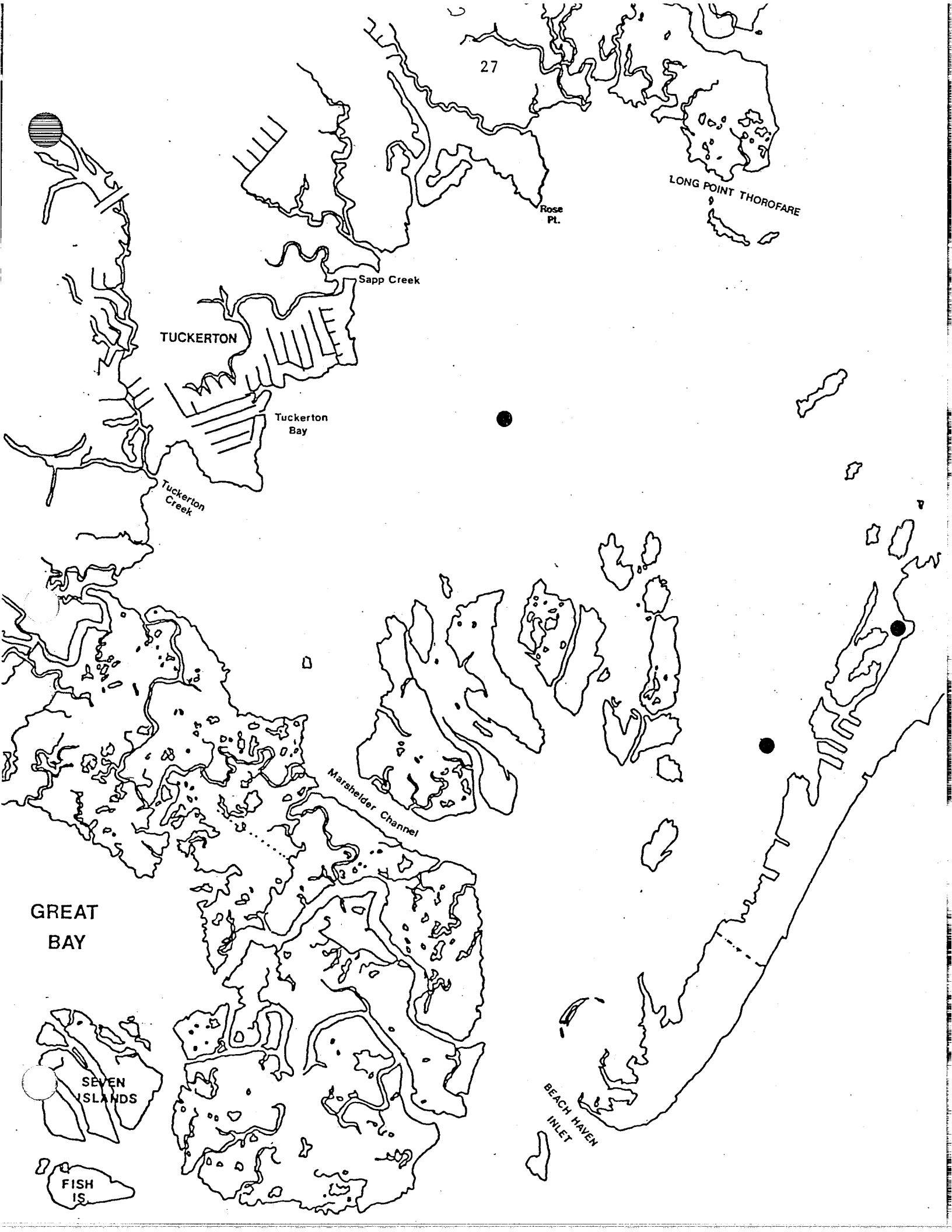
Fig. 6. Location of recaptures (●) of winter flounder based on tag returns from late December 1978 through 10 July 1979. Digits indicate multiple returns from one location.

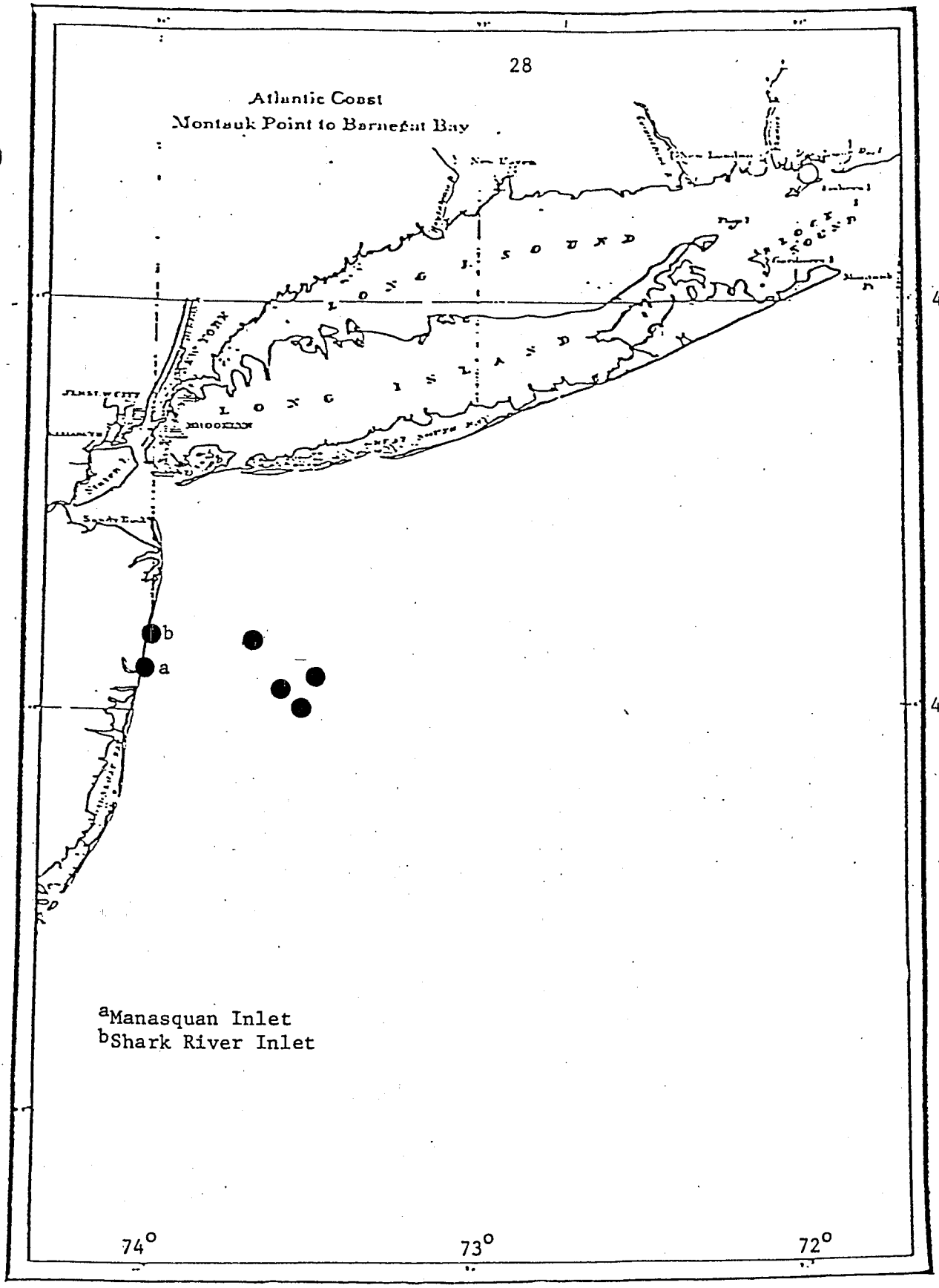

23
J. STANLEY
TUNNEY BRIDGE
TOMS RIVER
Good Luck
Point
OCEAN
GATE
HOLLY
PARK
CEDAR CREEK
ISLAND BEACH STATE PARK


24
SUNRISE BEACH
FORKED RIVER
7 taken at OCGS
2
OYSTER CREEK
SANDS POINT HARBOR
22 taken in fyke nets from Forked River to Waretown.
VARETOWN
BARNEGAT BAY
2
5
2
BARNEGAT INLET
2
DOUBLE CREEK
HIGH BAR HARBOR


GULF PT.
25
LOVELADIES
HARBOR
3
Turtle
Cove


MANAHAWKIN
BAY
MANAHAWKIN
BAY BRIDGE
MILL CREEK
CEDAR RUN
DINNER POINT CREEK
Westecunk Creek
LITTLE EGG HARBOR


LONG POINT THOROFARE
Rose Pt.
Sapp Creek
TUCKERTON
Tuckerton Bay
Tuckerton Creek
Marshelder Channel
GREAT BAY
SEVEN ISLANDS
FISH IS.
BEACH HAVEN INLET



[a]Manasquan Inlet
[b]Shark River Inlet

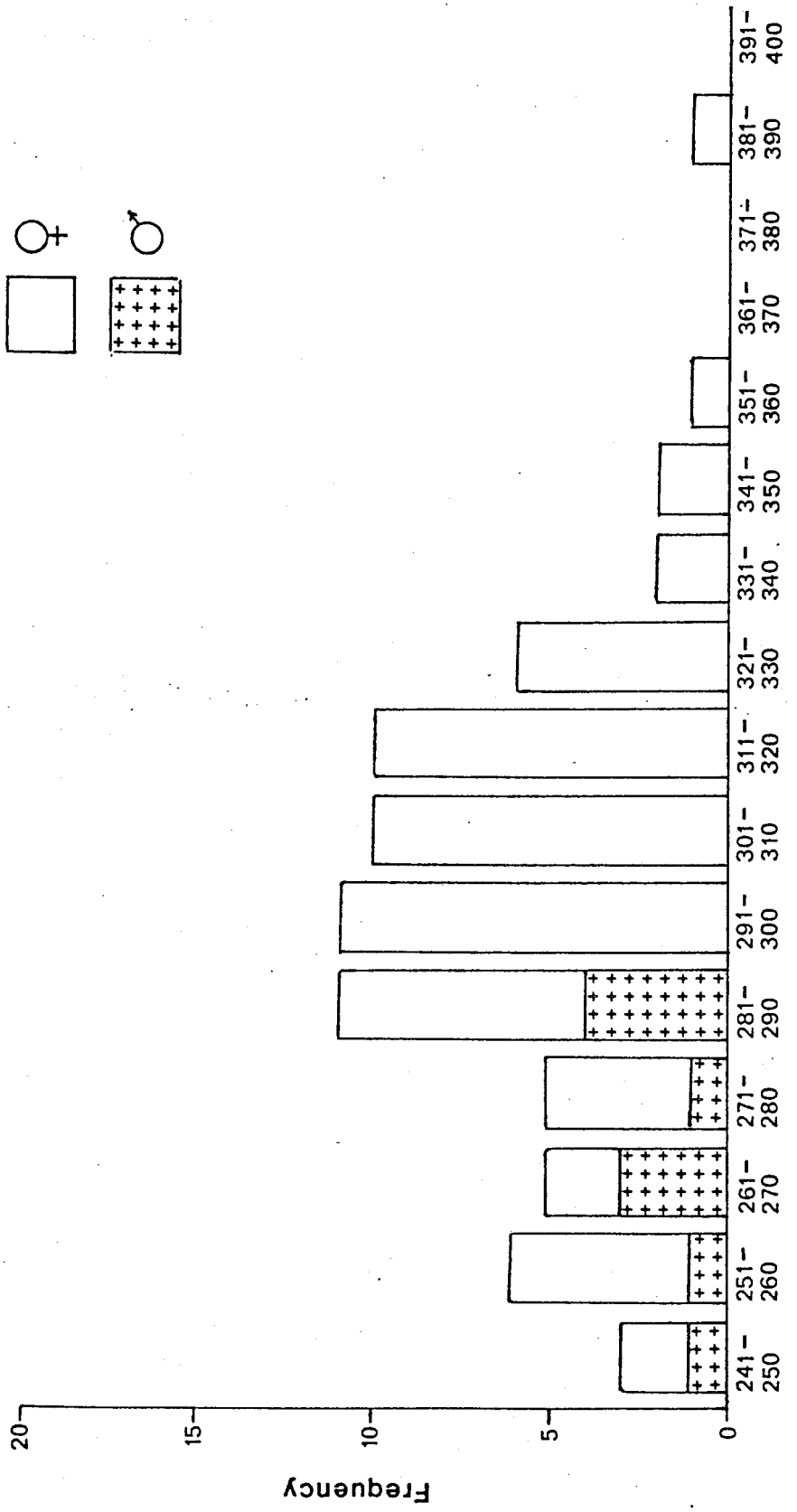


Fig. 7. Length-frequency distribution of recaptured male and female winter flounder based on tag returns from late December 1978 through 10 July 1979.